DOCUMENT RESUME

ED 426 636 HE 031 718

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TITLE	University Education and Professional Profile of Chemists: Tradition and Modernity.
PUB DATE	1998-04-00
NOTE	30p.; Paper presented at the Annual Meeting of the American Educational Research Association (San Diego, CA, April 13-17, 1998).
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	*Business; *Chemistry; College Curriculum; Corporations; Foreign Countries; Higher Education; Modernism; *Professional Personnel; *Science Curriculum; *Science Instruction; Scientific Attitudes; Traditionalism; Universities; *Work Attitudes
IDENTIFIERS	Brazil

ABSTRACT

This study examined the education of chemistry professionals in Brazil in light of the profile of such professionals in the current job market. Semi-structured interviews were conducted with 21 chemists employed by two foreign and one domestic companies in the state of Sao Paulo, Brazil. The chemists were graduates of the three major universities in the state--the University of Campinas, Methodist University of Piracicaba, and the State University of Sao Paulo. Chemists employed by the first company, a French multinational, recognized the economic aspects of the business and their work and were able to balance the technical and managerial functions of their jobs. Chemists employed by the second company, a family-run Brazilian concern, demonstrated neither particular enthusiasm or conflicts over their professional role. Chemists employed by the third company, an Argentinean multinational that had gone through several management changes, had trouble recognizing the economic aspects of their work and instead focused almost entirely on the technical nature of their jobs. The professional profile of chemists in Brazil is discussed in light of the chemistry curriculum at the three universities from which the participants graduated. (Contains 35 references.) (MDM)

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ED 426 636

University Education and Professional Profile of Chemists:Tradition and Modernity

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Paper presented to the Annual Meeting Of the American Educational Research Association, San Diego, California, April,1998 -Under the auspices of FUNDUNESP(Fundação para O Desenvolvimento da UNESP)

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OBJECTIVE

The objective of this paper is to reflect upon University Education of chemistry professionals in Brazil and the profile outlined by the job market.

THEORETICAL STRUCTURE

The following topics will be developed:

a) A historical brief of the origin of this field of knowledge as science and its incorporation to the industrial productive sector.

b) A brief about the establishment of University courses in Brazil and chemistry courses in this context.

c) An analysis of present industrial productive organization, establishing a parallel between the professional, expected by taylorist and fordist patterns of production, and in the context of "flexibilization" of production and globalization, fundamental aspects for the present productive organization.

Within this context Brazilian industry will be analyzed as well.

d) From the referential described above and the results of field research an analysis of the "professional" profile described by the chemistry professional and education courses available.

e) An examination of professional profile outlined by chemistry professionals, and graduating courses are presented based on the above items.

METHODS AND RESEARCH TECHNIQUES

Methods and research techniques applied:

a) Bibliographic study for a synopsis: – about the incorporation of scientific knowledge by the productive sector and chemistry in this context; – professional profile demanded in different stages of industrial development, focusing on fordism and flexible accumulation.

b) Semi-structured interviews with graduated chemists who work for companies in the State of São Paulo, Brazil, to obtain information about academic education received and professional performance – skills required by companies opposed to skills achieved during academic education. The interviews were called semi-structured for having the following guidelines:

–Place of graduation.

The most important aspect during graduation: research, practice for concrete problems, theory, and whether information about entrepreneurial organization was received by the student.

Job position in the company, if related to research, processes previously elaborated, management or others.

Freedom of action at work.

Use of knowledge obtained during graduation course for professional purpose.

Type of training received in the company. Training contents and format.

Contribution of training performed to: adjust to company principles, necessary contents to perform the present job, etc.

How you see your own job today.

How the relationship among workmates is like and hierarchic levels.

Relation among company structure, job satisfaction, and professional practice.

Job rank in the professional life.

c) Curriculum analysis of chemist graduating Universities. Three renowned Universities of the State of São Paulo where graduated professionals were chosen. The Emphasis given to the analysis of curriculum was related to contents of graduation courses based on University history and professional profile outlined by professionals interviewed and the dynamic of job market.

Three chemical companies were chosen: paint production (Argentine Multinational), chemical and petrochemical (French Multinational), and dying and raw material for the production of rubber (Domestic Capital).

Twenty-one chemists were interviewed according to the following table:

Company	Chemists Interviewed	Job Position	University
A		• Research Managers 3	UNICAMP
French		• Technicians 4	UNIMEP
Multinational	9	• Researcher 1	UNICAMP
B		• Lab Manager 1	UNESP
National	5	• Human Resources 1	UNICAMP
Capital		• Researcher 1	UNESP
		• Technician 2	UNIMEP
C		• Lab Manager 3	UNESP and OSWALDO CRUZ
Argentine			
Multinational	7	• Researcher 1	USP
		• Commercial Sector 1	UNESP
		• Technician 2	USP and OSWALDO CRUZ

UNICAMP - University of Campinas
UNIMEP - Methodist University of Piracicaba
UNESP - State University of São Paulo

One of the most important aspects of the analysis were the interviews with professionals, because the subjects – having a methodological theoretical referential – were participants in the establishment of social structures, not only passive subjects, but the ones who resist and re-elaborate established norms.

Therefore, the analysis did not have only a referential of principles and values from the point of view of company curricula formally established; but mainly chemists' interpretations of their professional experience.

SCIENTIFIC KNOWLEDGE, CHEMISTRY AND INDUSTRIAL DEVELOPMENT

The relationship between science and concrete issues of economic development and production starts with the development of capitalism, when the emerging new social class, industrial bourgeoisie, begins to observe science as a booster for development.

Before the establishment of capitalism as means of generalized production, until 16th and 17th centuries in Europe, the fundamental assets of scientific knowledge in the West was essentially of classic ancient times – ancient Greeks– as preserved by Arabian erudition and medieval monasteries.

Chemical industry – like other productive processes – undergo an artisan period, when manual abilities are essential, to a period when scientific knowledge is the main ally, according to Sherwood (1956)

> "...The old industries were arts, conducted by skills of eye and hand, acquired by long practice of the craft, for this skill there was no substitute. The new industry has steadily discarded judgment and skill in favor of analytical control, calculation of the optimum conditions and the check of experiment. The old industry owed its success to the skill of the worker; the new industry steadily discards the skilled worker in favor of the machine-culminating in the chemical separation of artificial radio-elements by remote control, unseen by any human eye."(pg. 12).

Science, after labor, according to Braverman (1987), was the last social asset to become an accessory to capital. Incorporation of science by the industry caused a change. From the domain of philosophers, amateurs, tinsmith, rich and idle people, to industrial organizations that start to finance them.

Some authors consider that incorporation of science by capitalist companies began in Germany, for while England and the United States seldom employed graduated scientists to help in specific problems, the German capitalist class had already established industrial laboratories, professional societies and commercial associations in the universities and sought government sponsored research, a continuos scientific technological effort as the new base for modern industry.

Adapting the French educational model, Germany renamed the polytechnical teaching of "technischulen" that grew apart from the University system and catered to the graduation of technicians and engineers. One of the most important aspects of this school was the close relation to commercial and industrial interests, connected to the same tradition of theoretical and scientific research developed in the universities.

The acknowledgment of this alliance with scientific knowledge for the development of industry is demonstrated by an American chemist, Ira Remsen that in 1894 explains why German chemistry industry had so well succeeded, through Mendellsohn (1964, pg. 21):

> "The value of pure science for industry has been recognized for a long time, much more clearly than in any other country, and the scientific method was established in factories, with great advantages for them. Individuals with deep knowledge of pure chemistry whose minds were enlightened with training at university laboratories are searched by the companies. The Germans were so convinced of the value of pure science for industry that at polytechnic schools the chemistry teaching plan was essentially the same as the one from universities, and some of the best purely scientific works were accomplished in the laboratories of these polytechnic schools."

At the same time in England, men of science sought acceptance of science for the society, trying to obtain material and spiritual support from the industry, government and university.

These men of science usually met at associations and academies apart from the university, and the British Association for the Advancement of Science - very active –, created in 1831, had the objective, at least in the beginning, to improve the conditions of scientists, scientific development and funding for scientific research by the government and industry, establishing a new relationship among science, government, industry and university.

Acknowledgment of the importance of science had yet another aspect: appraisal not only for applied and practical science but also pure science, a base for the first. The German chemist Justus Liebig, after visiting England, observed (Mendellsohn, 1964, pg. 47):

> "What impressed me most in England was to notice that only those works with a practical trend aroused attention and inspired respect. Purely scientific works, which deserve much more merit, are almost unknown. However, they are authentic and true sources from which the others derive. Practice alone never leads to the discovery of the truth or of a principle. In Germany, the opposite happens. For scientists here, practical knowledge has a secondary value. Only science enrichment deserves attention. I do not mean to say that this is the best; for both countries, without any doubt, the right balance between practice and theory will be ideal."

The consequences of science were not limited to the industrial fields. As Bernal (1976) affirms, beginning by B. Franklin, scientists of late 17th century were radicals and liberals in England as well as in France. Joseph Priestley and Lavoisier – outstanding chemists – had hopes of progress through constant development of science and industry. J. Priestley had his library and laboratory burned down for favoring the French revolution. Lavoisier was guillotined after suggesting radical changes to the new government after the French Revolution.

In the U.S., research laboratories in companies were established at about the same time of the concentration process of large industrial corporations and the systematic government intervention in the economy. In essence, however, the involvement between science and industry occurred differently in Germany due to a predominant laboratory vision of science to solve specific problems. As stated by Braverman (1987).

> "The tradition of a lean and easy empiricism did not offer favorable grounds for the development of a basilar science. Industry magnates, still impatient with free and non-oriented research, anxious for technical innovation for nuts and screws, did not mind to conceal, under their new compromise with science, disdain for their fundamental forms."(pg. 146).

This fact lasted until the Second World War when many German scientific talents, due to nazism, emigrated to the United States bringing a new vision to the relationship between science and industry. One consequence was a slight increase in research funding by companies and the government. Braverman

(1987) mentions that, as the budget for research and development increased, a characteristic scheme of financing and controlling emerged; most of these researches were financed by federal funds and controlled by private industry. Therefore, in the early 1960s, three fourths of this research were concentrated in engineering and physicoscience fields and were performed by companies, although the government directly funded three fifths of the cost and most of the remainder, indirectly, through fiscal incentives.

As a consequence of the gradual appreciation of the value of science for economic development, it was transformed into a merchandise, purchased and sold like any other implement and work of production. Consequently, as all merchandise, its supply is boosted by demand, leading it to meet the immediate needs of capital. From this reasoning, Braverman argues that:

> "The key innovation may not be found in Chemistry, Electronics, automatic machinery, Aeronautics, Nuclear Physics, or in any other product of scientific technology, but in the transformation of science itself into capital."

Therefore, since industrial companies have the basic objective of capital accumulation – generating profits to owners of means of production and shareholders – and the production of services and assets, the permanent estimate to obtain the lowest production cost is essential to itself. The introduction of any technical improvement may be subject to calculation of cost and benefit. In this perspective science and technology may be driven toward improving work process that results in saving resources and increasing profits with the speed demanded by the market.

As D. Harvey (1994) states, in a world of fast changes in taste and needs, and flexible production systems, knowledge of the latest technique, the most recent product and scientific discovery, brings the possibility of reaching a major competitive advantage. In this picture, knowledge itself becomes a merchandise to be produced and sold.

The possibility of economic development and improvement of the working process, however, does not refer only to the incorporation of new technologies, but also to factors such as entrepreneurial capability, satisfaction of objectives and employer identification with the organization. Therefore management and training of professionals within general principles of the company become one of the elements of knowledge appropriation.

Today, observation of this last factor is a strategic element for companies, establishing that the concern with "human resources" is as important as the introduction of technologies of production or improving products.

The incorporation of technique and science to economic development came together with the development of techniques for job management that, with time, constituted in techniques connected to production itself and to preparing the "new man", adapted to the new demands of the productive sector.

Two fundamental aspects stand out in the issue of flexible accumulation where new techniques and new organizational means of production were established. The first aspect is the access to scientific and technical knowledge setting an organized production of knowledge with a marketing characteristic (Touraine, 1994), asserting the appropriation of such types of knowledge, emphasizing the characteristic of their immediate application. The second aspect is the importance of controlling the information flow and advertising vehicles of taste and popular culture, promoters of cultural values.

BRAZILIAN INDUSTRY AND CHEMICAL INDUSTRY: SOME CONSIDERATIONS

The understanding of the industrialization process as well as the current state of Brazilian industry, especially the chemical industry, in the world panorama, is fundamental for the analysis proposed by the present research. Thus a synopsis of some studies of these issues will be presented, for although two of the researched companies are multinational, they have been established in Brazil for a long time and have Brazilian professionals in their management positions.

Two fundamental characteristics of the Brazilian industrialization process to be pointed out are the late industrialization started between the First and Second World Wars and the model of import substitution. The first period was centered on production of consumer goods. The second, in the 1950s, when industrialization intensifies, was centered on massive imports of technology and the strong presence of international capital. As Cardoso states (1972).

> "The governmental interest for a fast development led to the choice of a model for industrial development that foresaw on massive investment of foreign capital in mechanical and heavy industry the means to rapidly change the traditional balance of the Brazilian manufacturing economy, based on food and light industry" (pg. 117).

The policy of import substitution, based on massive import of technology, had a lesser appreciation of science and technological development – an investment bellow 1% of GDP per year. Companies of the productive sector shared less than 10% of this investment during the last decades. In developed countries this investment ranges from two and three percent of GNP – private companies shared forty to fifty percent of national expenses in this field.[1]

Coutinho (1940) states that from the mid 1950s, with the rising protection of the domestic market to imports, segments manufacturers of durable consumer goods and intermediary goods of improved technological complexity whose technical base, at world levels, were at an advanced degree of maturation. The industrial strategy followed by such introduction occurred basically

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[1] Information by the Minister of State of Science and Technology, José Israel Vargas in Coutinho, L. (org.) ESTUDO DA COMPETITIVIDADE DA INDÚSTRIA BRASILEIRA. Papirus, Campinas 1994.

through direct investment of foreign companies, especially in the segment of durable goods and from state investment in segments of longer period of maturation and larger capital requirements.

The process of import substitution, incorporation and dissemination of more modern technologies took place through constant search of foreign technologies on the part of a relatively reduced number of leading companies. There was a systematic increase in the explicit import of technology and technological services, without an internal systematic parallel technological effort or subsequent to the external purchasing process of technology.

Thus it is stated that:

> "... even at the last stage of the cycle of import substitution, technological capacitation was not an effective requirement. The internal technological effort was basically restricted to learning and using of production procedures, being necessary, at the most, the adaptation of processes, raw material and products.
> The market opening in the worldwide context of globalization, established the need, especially from productive sectors, for Brazilian industry to adapt to the situation. The entrepreneurial culture resulting from an industrial development directed toward import substitution, with strong governmental intervention, is readapting under the changes. In this picture, the competitive capacity is established in the context of a competitive environment and free market rules (Coutinho, 1994)."

Yet, Coutinho states that multinational companies established in the country, usually develop an organizational format derived from the head office, increasing the capacity of modernizing and managing. National companies are generally of a smaller size, having managing procedures where family control and hierarchical management prevail, as opposed to multinational companies.

However, according to Coutinho (1994), in the 1980s a new organizational format was established, that in terms of production, made large scale production compatible with the possibility to differentiate and improve products. It also made obsolete strongly hierarchical and vertical organizations, showing the following table of development of organizational format for competitive companies:

Decision Making Processes
Rising decentralization
Decreasing number of hierarchical levels
Rising employee participation in decision making and company revenues

Information flow
Horizontal
Rising intensity

Products

Rising catering to clients specifications
Rising efforts of development

Productive Processes
Constant improvement
Rising flexibility
Low level stocks
Less dead time

The chemical industry in Brazil, was definitely established in the industrial park thirty years ago, where multinationals are abundant. This can be seen at table 1 – production of Brazilian Chemical industry in 1983 by shareholders.

In terms of development of the chemical industry it is important to point out that it is based on scientific knowledge: its research structure and development are of major importance; also pointing out the differentiation among various segments of chemistry.

In a study about innovation of fine chemical sector, Mercado Suarez (1992) shows some characteristics related to chemical industry in this sector that meet the analysis of the situation of Brazilian and international companies.

TABLE I
Production at Chemical Industry by shareholders

SECTOR	STATE		PRIVATE NATIONAL		TRANSNATIONAL		TOTAL	
	$ US	%	$ US	%	$ US	%	$ US	%
Basic Organic Chemistry	191.8	5,0	1841.3	48.0	1802.9	47.0	3836.1	9.1
Inorganic Chemistry	371.0	25.0	474.9	32.0	638.1	43.0	1484.0	22.9
Fine Chemistry	---		220.6	23.0	738.4	77.0	1484.0	22.9
Vegetal and Animal Products	---		127.5	61.0	81.5	39.0	209.0	3.2
TOTAL	562.8	8.6	2.664.3	41.1	3260.9	50.3	6448.0	100

This author points out the importance of the relation consumer-producer (in companies of fine chemistry of national capital) as the driving force for innovation, citing Freeman's study (1990), that demonstrates that successful and innovative companies were characterized by understanding and catering to the needs and circumstances of potential consumers.

Mercado Suarez points out three main aspects as obstacles for development: lack of personal qualification, management capability and the market issue. Lack of qualified personnel is the main obstacle for developing the

companies researched by this author, as shown in table II. The main criticism is the inadequate education of professionals to specific demands of different branches. In some cases, these professionals need to be trained for one year or more in the company to adapt to its requirements.

Managing capability is also a problem for innovation at Brazilian companies researched by this author, especially at companies established by university professionals. The technological aspect is as an important aspect as managing capability for the success of these companies.

The need to expand the market is also a motivation for technological innovation. Companies that focused on the internal market had problems to develop. They had to resort to exporting markets.

This conclusion meets the general analysis that debates the issues of competitiveness of companies in the present economic panorama of market globalization and flexibilization.

TABLE II – PROBLEMS THAT HINDER THE DEVELOPMENT OF COMPANIES IN THE DOMESTIC FINE CHEMISTRY SECTOR

Technical Problems	Companies	Frequency
Lack of qualified personnel	14	48.3
Difficulties obtaining input	14	44.8
Reduced Market	13	44.8
Productivity Problems	12	41.4
Reduced Scales of Production	09	31.0
External Technical Services	09	31.0
Spare Parts Acquisition	07	24.9
Diversification Problems	06	20.7
Maintenance Problems	06	20.7
Cost Distribution	06	20.7
Quality Control	04	13.8

CHEMISTRY EDUCATION IN BRAZIL AND OBSERVATIONS ON CHEMIST EDUCATION CURRICULA

A SYNOPSIS OF UNIVERSITY COURSES IN BRAZIL AND CHEMISTRY COURSES

According to Florestan Fernandes (1979), the model of university courses in Brazil established a Brazilian standard for graduate schools with fundamental parameters such as:

– assigning techniques and knowledge incorporated from abroad that rarely place educational relations within a creative and innovate spirit.

– appreciation of "bachelor status" in spite of his/her activity or fundamental contribution.

– the creative gravitational axle originated out of technical and professional specialization occurred independent from the university institution due to individual efforts of professors and students' demands.

According to Florestan, this standard would screen both private, state and federal universities.

The university reform of 1968 had two conflicting poles: student unrest and governmental response to demands of the social process in development, lacking innovative and efficient solutions (to the university issue).

Emphasis on technological professions instead of traditional careers and even human sciences, fail to introduce a new teaching behavior toward scientific and technological production expected for the development of the country, but stressed tendencies of traditional university education due to political and economical context.

Analyzing these issues, Kawamura (1990) affirms:

> "The dividing characteristic of teaching, specialized and preparatory (since during the race to introduce new technological innovations, large companies were ahead of the schools), brought job market problems to graduated students. Although ideologically graduated to occupy managing posts, especially the ones from technological sectors, they were employed at subordinate jobs, segmented and repetitive, similar to factory workers' posts. Students start to be concerned about the lack of thoughtful analytical subjects in the humanities for understanding political and economic issues of the profession."

In Brazil, chemistry education at university level kept the pattern and, at first, was managed by two institutions with two different objectives.

The National School of Chemistry was founded in 1934 in Rio de Janeiro. It offered a course in industrial chemistry, with no intention of having a research line. In 1951, after changes in the curriculum, this course was named chemical engineering course and the specific teaching of chemistry was only re-established years later (Schwartzman, 1979).

The chemistry department of the Philosophy College, with German tradition, under the supervision of Heinrich Rheinboldt was established at the same time as the University of São Paulo. Besides the basic course of licensure it offered a doctorate degree, European style, where doctors worked on original research for four years under the supervision of professors, when they then defended their thesis (Schwartzman, 1979).

Notwithstanding the German tradition during the establishment of chemistry courses at USP, research was developed as an academic activity, characteristic of this tradition.

Among the causes, pointed out by Simão Mathias in Schwartzman (1979), are the control of chemical companies by multinational

companies in the country and lack of scientific and technological policy by the government that fails to present specific demand for researchers in the field:

> "Almost all our chemical industries are controlled by multinational companies, either belonging or being a branch of multinational companies. And all research laboratories owned by these industries are located in their country of origin. They do not have any interest in developing scientific research in Brazil.(. . .) And the industry as well as the government distant themselves from chemistry departments (...) no relevant issue has been proposed to us for research". (pg. 270).

The establishment of other chemistry graduating courses was based either on a research approach, more restricted to public universities where there is a greater involvement with this sort of job, or by a technical approach, as in private universities.

CHEMISTRY GRADUATING COURSES, SOME CURRICULUM OBSERVATIONS.

Professionals from the following chemistry graduating universities were interviewed:

a). Public: UNESP - State University of São Paulo (Universidade Estadual de São Paulo), USP - University of São Paulo (Universidade de São Paulo), UNICAMP - University of Campinas (Universidade de Campinas), UNIMEP - Methodist University of Piracicaba (Universidade Metodista de Piracicaba) and FACULDADE OSWALDO CRUZ - Oswaldo Cruz College. We chose to analyze course curriculum of UNICAMP, UNESP, UNIMEP due to their similarities, with a graduating characteristic of scientific research, although with different origins. UNIMEP was chosen for having a greater number of chemists graduated there that came from private colleges and for having easy access to data.

A) Chemistry – UNESP – ARARAQUARA (São Paulo State)

The chemistry course at Unesp, located in Araraquara, was established in 1960, at the old Philosophy Sciences and Education College of Araraquara.

In 1976, with the establishment of UNESP, the Chemistry Department where chemistry was taught gave birth to the Institute of Chemistry. The course then was transferred from F.F.C.L. to the new institute.

The chemistry course at UNESP - Araraquara has three qualifications: Bachelor's degree in chemistry, Technological Chemistry and Licensure in Chemistry.

The educational project of the course outlines chemist's profile through professional qualification whose actives are given below:

1) Directing, supervising, planning, coordinating and technical responsibility within the scope of their respective qualification.

2) Support, advice, consulting, budget development, marketing and commercialization, within the scope of respective qualification.

3) Inspecting, examining, appraising, arbitrating and technical servicing, preparing opinions, reports, certificates, within the scope of respective qualification

4) Teaching practice, according to specific legislation.

5) Performance in the job and in technical position, within the scope of respective qualification.

6) Experiment and research in general. Research and development of methods and products.

7) Chemical and chemicophysics analysis, biological chemistry, bromatological, toxicological, and legal, standardization and quality control.

Activities 2 and 13 – the commercial, technical and economic activities of the chemist – stand out.

This course has undergone a number of changes, especially since 1991, with the following most significant changes in the educational project:

A) Emphasis on the bachelor's degree of chemistry graduated professionals to perform in different fields of chemistry, the new curricular structure re-established a broad and basic education of the bachelor.

B) Concern in avoiding contents excess, and introduction of updated issues to "modernize the course".

C) In "the principles that direct the education of the professional" – for the bachelor in technological chemistry - this curriculum "may privilege the technical education and treat academic issues with less intensity. Notion of interpersonal relationship and industrial organization are complementary to the education of a professional aware of his/her ethic role in the society he/she is attached to."

Although these aspects belong to the Educational Project and there is a concern in bringing together academic education and professional performance, especially related to industry, the chemistry curriculum lacks disciplines with contents that approach the above issues.

Disciplines from industrial chemistry curriculum incorporate issues linked to industrial environment, such as: unitary operations, science of materials, industrial organic processes and so on, but lack disciplines related to job management that provide students with a job perspective in the industry.

Curricular training, which may bring experience for a concrete link between academic education and professional practice, fails to take shape for being not mandatory in companies. It may be developed at university laboratories or at ongoing research. The possibility of an interactive training between university and industry is a proposal already introduced in this course. One of our interviewees took part in this experience that did not occur again.

B) CHEMISTRY UNICAMP

UNICAMP was established by decree-law number 7o55-1962, within principles of economic context of the period and which were incorporated in the University Reform of 1964.

The founding principles of UNICAMP, although stating the intention to "overcome utilitarianism and mechanization of the principle", sought the graduation of scientists, humanists, engineers and technicians for the job market, but stressed the importance of having a basic education in order not to become ordinary professionals in their development, but also able to have a critical thinking about national issues.[2]

The Chemistry course of UNICAMP and UNESP comprises three qualifications, Bachelor's degree, Bachelor's degree in Technological and Licensure in chemistry. The essential difference between them is the fact that the bachelor's degree is "specially directed toward pure and applied research" and technological chemistry "is mainly directed toward industrial activity".

The course has a common nucleus where two disciplines stand out: hygiene and industrial safety, and chemistry and safety.

The curriculum privileges the basic education of chemistry, as in the curriculum of chemistry at Unesp - Ar. Some disciplines are included in the qualification for technological chemistry: Introduction to industrial Processes, microbiology, and fermentation.

The attempt to bring together academic education and industrial environment is accomplished in a discipline where students develop projects ordered by companies. Besides developing activities that demand scientific knowledge, they are responsible for preparing an estimate of cost - benefit of research ordered. This opportunity enables the student to have a closer view of professional reality – in a consulting sense, not as a professional that is involved with the industry and its culture.

C) CHEMISTRY – UNIMEP

The chemistry course at UNIMEP offers only the qualification in industrial chemistry and is a night course. Differing from the other two universities by having been established concerned with the industry and a clientele already present in the job market. The curriculum of the chemistry course at UNIMEP has specific disciplines of technical knowledge that do not greatly differ from the other two mentioned. The difference is that in this curriculum disciplines are incorporated with a humanistic characteristic such as sociology, economy, methods and techniques of research and two optional disciplines. The curriculum also incorporates a discipline called "Industrial Organization" where, at first, aspects related to functioning and managing of industrial organizations should be considered.

Professionals graduated from this course were interviewed and kept the same appraisal of distancing between knowledge acquired

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[2] Silva,J.M.A. de P. "O Ciclo Básico da Unicamp: Projeto, Realidade e Perspectivas". Master's dissertation, Education College unicamp,1989.

during graduation, and reality of professional practice, pointing out the lack of contribution offered by the course, including laboratory experience.

Disciplines directed toward managing capability and of organizational structure lack efficiency, for only one professional mentioned the discipline industrial organization and yet was unable to remember the issues addressed by it.

CHEMIST PROFESSIONAL PROFILE: PERSPECTIVES AND EDUCATION IN THE GLOBALIZATION AND FLEXIBILIZATION CONTEXT

In the ideas introduced it was stressed the marketing characteristic adapted by scientific and technological knowledge, leaving behind the exploratory, world understanding, and ornamental side, and gradually adopting, from the industrial revolution, a utilitarian and economic characteristic.

Management patterns and administrative and organizational theories go from the study of the best possible alternative to perform tasks to the concern with control vehicles for establishing and spreading cultural values.

In this picture, man's profile, sought in different steps of appropriation of knowledge, achieves a distinct character. With taylorism, attention was paid to its tasks and man's adaptation to it. With Fordism, besides routine and shared tasks controlled at production level, rationalization of work seeks a man shaped not only by technical patterns of industrial organization but also by moral values. The following citation clearly points that out:

> "In 1916, Ford sent an army of social assistants to the homes of his privileged workers (mostly immigrants) to assure that the new man of mass production had the sort of moral integrity, family life and prudent and "rational" consumption capacity (non alcoholic) to correspond to the needs and expectations of the corporation (Harvey, 1994).

The human profile restructures itself as the productive and managing patterns are redefined.

Therefore, with the rising adoption of flexible accumulation by companies, and economic and social policies of neoliberal orientation, the professional profile required by the market introduces the need for requirements that in some aspects differ from previous ones.

The reduction of hierarchical levels and the requirement for more involvement and participation of the worker to develop his/her job, as well as the importance of the market to delineate social and economic policies are defining elements of these requirements.

In this picture, there is a demand for instructed workers able to re-elaborate their work, take initiatives, not only accepting but eager for changes, asserting the work and its product as their own, in a collective and cooperative structure. They may also observe the principle that the next production step - where service is rendered –, and his/her workmate are clients that should be taken into consideration in the process.

The search for legitimizing the social and economic structure of the market meets managerial theories that have in the concept of "client" one of its principles.

Creativity, expression that, at first, accompanies the performance of graduated professionals, since they normally fulfill management positions in the productive sector, has peculiar characteristics in this context, as stated by Furtado (1972):

> "The consumer is given an essentially passive role: his rationality consists exactly in correctly responding to each stimulus that he is subjected to. Innovation points to a higher level of expenditure that is the distinctive characteristic of the privileged consumer. But the previously restricted pattern will have to be excelled and expanded for the market to grow in all directions. The laws for this growth restrict creativity".

Touraine (1994) states that the word consumer had been dissociated from the word production for a long time; the production society opposed market society; however, managerial theories that have the client as its main focus have the principles that production and consumption are associated. The fellow worker is a potential customer, the production team is a customer, the student is a customer and so on. Scientific and technological knowledge, however, acquires marketing characteristic which is then placed in function of market demands.

Applying scientific and technological knowledge by graduated professionals, through their performance in industrial organizations, is delimited by social and economic conditioners, defining a change in the profile of these professionals to adapt to structures and organization forms of management and production.

As seen before, the chemical industry is established strictly linked to research and academic laboratories; therefore, the work of the chemist is traditionally related to a wider involvement with scientific investigation, not only in university education but also professional practice. Practice, however, relativizes this research concept, according to conditioners of industrial production and the historic moment.

The results of the interviews at three researched companies demonstrated some differences concerning the professional profile established by chemists who were considerably in accordance with principles that guide these companies. These principles are related to the management model adopted and to the degree where they promoted innovations that brought them close to international entrepreneurial standards of flexiblization and globalization.

Globalization suggests an idea of "world community", "world with no boundaries" where "Everywhere, everything looks alike, to the extent that the preference structure of the world is pushed to a common homogenized point", as stated by Levitt (Ianni 1995). Thus, the search for identifying companies with patterns of a "global company" leads them to innovations that place them within this world community and keep them productive.

Globalization and technological development, however, do not mean overcoming social, economic, political and cultural inequalities as well as economic and ideological dependency. Aspects such as the inexpensive labor reservoir in developing countries and the development of transportation and communication techniques enable production to take place anywhere in the world, to a worldwide asserted market and, as stated by Kurz, where the individuals reveal themselves as adjectives, subordinates (Ianni, 1995).

> "The universal reason, supposedly absolute, was reduced to mere functional rationality to the service of the process of money appreciation that does not have a subject, until the unconditional capitulation of the so called "spiritual sciences". The abstract universalism of western reason revealed itself as a mere reflex of real objective abstraction of the money".

Management theories in the context of globalization and flexible accumulation cover these aspects as they try to establish in the individuals the feeling that the ones that work hard and believe in these principles will be accepted with equal conditions to the richer and more developed group. Hence, they go through the illusion that "profit," not "quality" is the essential principle of the new culture to be established at industrial organizations, this being a fundamental requirement of their competitiveness.

The issues discussed herein, referring to the principles of flexible accumulation and management theories, were referential to the analysis used in the perception of the professional profile of chemists, for companies established in Brazil have also made efforts to be placed in a globalized market – as a means of survival – that differ according to established directives, reflecting upon the definition of the professional profile required.

Some elements defining the profile of the professional, outlined by chemists and by guiding principles of the companies, according to the ideas presented, were: a) characteristic of the job and the direction of creativity; b) degree of involvement and independence or incorporation of values and guiding principles of production; c) new skills required in this context.

The characteristic of the job and the direction of creativity outlined by professionals in view of innovations or the establishment of management theories support the understanding that, essentially, their work has a characteristic of investigation and research, but with a clear difference between the concept of investigation accomplished inside the university and industry.

A table with the main characteristics of the companies and the professional profile delineated by the chemists follows:

MANAGEMENT MODEL AND PROFESSIONAL PROFILE

Companies	Management Model	Professional Profile by chemists
Companie A-French Multinational - drugs, agricultural input and petrochemical products -3500 employees -high technological investment	-Since 1990 it adopted the T.Q.M. New attitude and cultural change toward the work were the main objective:cooperative work, breaking of the hierarquical level, more participation and involvement of the professionals were the base for the cultural change	-the function of chemists was linked to research -management knowledge together with technical knowledge were considered important - in this company the professional especilizes only in one sector - creativity was considered as the ability to suggest and search for improvement - the company offers possibilities of improvement to the professionals throught training in another unit of the company courses.
Company B -Brazilian Company) - dying and raw material for the production of rubber -700employees -low technological investment	-This company has a family administration. The policy and direction are determined by the owner - a T.Q.M. training began but due to strikes this training was interrupted	- Same as company A, the function of chemists is linked to research activity -the management knowledge was not considered essencial because this function is executed by the owner - the professional is relocated within different sectors of the company and creativity is seen as the ability to improvise in daily practice - the company expects the professionals to have their own training and professional improvement
CompanyC- ArgentineMultinatrional -paint industry -2500employees -middle technological investment	-This company went throught three periods of management.The first was a family administration.The second was a management policy when the commercial sector was predominant over the technical area.At that time innovations were introduced, as the use of neurolinguistic.The third phase was a balance between the technical and commercial area.	-same as the other companies the chemists linked their function with the research area -the view of chemist's work seems more linked to technologicaldevelopment than market -management knowledge was considered important as well as in company A. This fact shows an involvement

Creativity of research that is accomplished in the industry was based on earlier thoughts directed to market demands, no longer being an "exercise of free spirit", especially in companies that adopted management innovations and where technological investment is high. At companies of family-oriented management, creativity was restricted by directives established by the owner and was presented more as a characteristic of improvisation and adaptation of processes already developed than a creative one.

The possibility of creation inside industrial organizations has been limited by conditioners of this model of accumulation since de beginning of the incorporation of science and technology to industrial processes. In the

globalization and neoliberalism context where the focus is on the market, the possibility of creation is even more restricted, for the ones who may have the role to create take the position of consumers whose rationality consists in responding exclusively to stimulus from this market.

This issue is closely linked to the degree of independence that chemists place themselves to organizational directives of the companies studied.

The perceptions related to company culture and professional profile demonstrate that although managerial principles of the three companies may have been defined on similar theoretical bases, especially total quality management, they were established and incorporated in different ways by chemists.

At company A a balance with the principles established was observed, a sort of enthusiasm by the directives implanted, especially related to the fall of strict hierarchical structures and the possibility for the professionals to have a broader participation in defining their work. This last principle is very significant in the expression "business owner" used by some chemists when referring to their jobs.

The discourse that identifies the professional as a "business owner", that is, that gives the professional the feeling that he is under control of a determined sector or technique, is established in a sort of compromise and responsibility that transfers the control of work, previously exercised by a "chief" or supervisor, to a level of individual consciousness. Hence substitution of the command position by the leadership position, acting more as an articulator than a supervisor, for this supervision is accomplished by each member of the organization over each other.

The main differentiation aspect between company A and company C was characterized by the resistance of C chemists to link the technical to the commercial area. It was noticed a great indignation by some chemists when referring to changes occurred for the improvement of the commercial area and to strengthening decisions from production directives.

For the chemists that regard their professional practice in a scope that maintains some characteristics of investigation and research, the supremacy of the market – principle that guided the reformulation mentioned –might hamper the possibility of any creation from "the technical area", as they refer to their field. Only the market would define the directives of their work. In strategic terms, they consider it unattainable for supporting production; as they themselves state, *"Obviously what is available in the market is something that has been experimented long before in the laboratory. They do not realize that years have gone before the product is launched in the market"*.

This understanding of the limitations of market integration, presented by chemists has an important meaning when acknowledging that the illusion of globalization and the breaking of barriers, as previously stated, does not overcome economic relation dependency by itself, since market reproduction restrains scientific and technological development, and creation is lacking.

Chemists of company B showed neither considerable conflicts nor enthusiasm as the previous ones; however, keeping a stand-still position, for they have a certain understanding that both technological infrastructure as well as the predominant family-oriented model of management is due to monopolistic characteristics that companies maintain in the country.

In the globalization panorama, however, productive and administrative structures of the company B are unable to present competitiveness at the same level as companies that are adapting to this new reality, for in this picture, sustaining monopolies is harder since increasing product supply and market diversification demand more flexible structures.

The skills required by the job market, that is, the professional profile outlined– differed from companies with management innovations, and with a family-oriented model of management. At the first, skills related to the capacity of market and business management came together with the skills of specific technological knowledge.

The common point in the discourse of chemists was the nature of investigation and research that characterizes their function. The diverging point was whether management and economic skills were important in their education, due to job market demands.

At company A where the managerial principles adopted are better defined and assimilated, the professional interviewed presented an accurate view of company principles, displaying the other side of his technical function, a demand for a broader knowledge to understand their activity in the economic dimension.

At company B, the requirement for professional with a profile of an education with knowledge in business and technical management, to this date, is not commonplace, since the first function is the owner's attribution, not the chemist's.

At company C, the resistance of the technical area to accept the supremacy of the commercial area in defining the course of his/her work, was established in the perception that the job of the chemist in this company would be related to an investigative work and to the dynamics of technological development rather than to market dynamics. The professional profile outlined then, tended to appreciate the technical education and the investigative spirit of the chemist, function whose performance may not be determined only by market conditioners.

The skills of technological knowledge deserve some considerations due to the established differentiation between specialization and the broad performance of the chemist in these companies. At companies not yet adapted to the globalization context, that have been promoting management and technological innovations, companies A and C, chemists develop a specialization or are hired for having a specialization in specific strategic areas, opposed to company B where the

chemist goes through different specializations in chemistry, without specializing or investing in one specific technique.

The basic knowledge for specialization at company A is acquired at the company itself, mainly at company headquarters, having a strong link with the management proposal established by this company – administrative decentralization – establishing leadership at specific sectors, as "business owners", and adopting a greater compromise with the company.

The broad performance of the chemist at company B is explained by centralized administration. These chemists must have enough general knowledge to accomplish necessary adaptations to the processes to be developed.

ACADEMIC FORMATION AND PROFESSIONAL PRACTICE

The curricula of graduating courses for chemists demonstrated a great deal of similarity since they are essentially based on technical knowledge, characteristic of this field of knowledge. Although there are some attempts for a greater approach to academic knowledge with professional practice, there is a great deal of distancing between what is performed at academic level and industry.

This distancing may be attributed to some factors such as:

A) On the one hand, the resistance of the university community for a more extensive approach to the industry, that may be related to the concern of losing the identity of the university institution and a link to industry standards, with a consequent loss of critical referential as well as the bureaucratic structure of the university institution that hampers diversification accompaniment and the agility of industrial production and market.

B) On the other hand, industry understanding that university institution may have to be guided by the market, adapting according to requirements of industrial patterns instead of being a space for alternative reflection on social issues, that, besides thinking of concrete production problems, also thought about social development, apart from market logic.

On the possibility of an approach and cooperation between two organizations it is necessary to understand the nature that characterizes each one of them, so that this cooperation can happen at an equal level and in a critical manner, not simply integrative.

Therefore, research performed at the university as well as the education offered may not be directed toward the interests of the industry, for by this way, university interest would be subjected by the industry, establishing an unbalanced relation concerning the autonomy of these distinct organizations.

The modern university, established from the concern of incorporating scientific investigation, basic or applied, is the safeguard and reproducer

of knowledge that is the base for producing interested knowledge. To keep this characteristic, as expressed by the professionals themselves, this organization needs different referential and periods of time from the ones determined by industrial organization.

The industry, however, has the profit as its main motivation, even disregarding more human, more interesting and creative ways to accomplish such objective.

The model of accumulation, as mentioned before, even in the flexibilization and globalization, is still the capitalist one, and market reference as a regulatory element of economic relation as well as social prevents creation perspectives as a true intellectual exercise.

Therefore we may conclude that academic education ought to cover all necessary elements to enable the professional in the scope of entrepreneurial policy, management and technique, incorporating new tendencies of job organization at companies, but protecting an open space for creation that characterizes university organization.

CONCLUSION

The historical brief attempeted to bring back the investigative character and the origin of science and technology as pure kmowledge before its incorporation to the productive sector.

The incorporation of scientific knowledge to industrial development and the different historical, economical, social and political contexts, generate different reorganizations of production and job relations.

The professional profile in these different contexts changes due to an adaptation of the industries to a world order.

In the context of globalization and flexibilization of production, the market searches for professionals that combine their formation with the managerial one.

Through the professional profile delineated by chemists, some aspects of the new skills were presented , such as management leaderchip, collective management and fast changes and constant improvement of the technological knowledge.

The incorporation - in the curriculum of graduating courses - of elements that aloow the professionals to understand economic aspects of scientific and technological knowledge was an important observation made by the chemists.

Althought the considerations of the necessity of respect for the differences of origin and objects of university institutions and companies, some actions may be considered to bring university education closer to the job market.

Experiences developed by one of the researched universities where the curricular training constituted in a space of relation between the universities and the industry are important in this sense.

In the curricular training, students are able to research issues of the industry through research projects developed together with the university.

Therefore the students, under the supervision of a researcher of the university and a representative of the industry, would be developing their technological knowledge and learning about cost, market and pratice applicability of knowledge acquired in the university.

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